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AN EVALUATION OF DENTAL CALCULUS FORMATION RATE
INDICES IN ANTARCTIC PERSONNEL

by

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and

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Bureau of Medicine and Surgery, Navy Department
Research Work Unit MR005.20.01-6025.03

Released by:

James E. Stark, CAPT MC USN
COMMANDING OFFICER
Naval Submarine Medical Center

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SUBMARINE MEDICAL RESEARCH LABORATORY
NAVAL SUBMARINE MEDICAL CENTER REPORT NO. 600

Bureau of Medicine and Surgery, Navy Department

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SUMMARY PAGE

THE PROBLEM

The high prevalence of periodontal disease in the Navy necessitates the study of all factors associated with the disease. Dental calculus has long been thought to be associated with periodontal disease. Calibration of criteria for evaluation of calculus formation rate and composition is required.

FINDINGS

The Volpe-Manhold method of calculus assessment is a relatively precise and reproducible method for calculus formation rate determinations. Its ease of use recommends it for population studies. Depending upon the study being conducted, the use of only one maximum score for each tooth and a collection time period of no more than two months would appear to be warranted.

APPLICATIONS

This index can be used to good advantage as a method of measurement in any dental calculus study of at least one month duration.

ADMINISTRATIVE INFORMATION

This investigation was conducted as a part of Bureau of Medicine and Surgery Research Work Unit MR005.20.01-6025—Study of Oral Health in the Antarctic. This report has been designated as Submarine Medical Research Laboratory Report No. 600. It is Report No. 3 on this Work Unit and was approved for publication as of 28 October 1969.

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ABSTRACT

The high prevalence of gum diseases in the Navy requires that attention be given to any factor associated with these diseases. Dental calculus (tartar) has long been implicated as having a role in gum diseases. Accurate measurement methods are required for studies in formation rates. One measurement index, the Volpe-Manhold Index, was evaluated using as subjects naval personnel wintering-over in the Antarctic. Results indicate this to be a precise, reproducible index which should be useful in any calculus study.

AN EVALUATION OF DENTAL CALCULUS FORMATION RATE INDICES IN ANTARCTIC PERSONNEL

INTRODUCTION

The effect of dental calculus upon the initiation and progress of periodontal disease is somewhat equivocal; however, the relationship is present (1, 2, 3, 4) and the need for calculus studies in Navy preventive dentistry and environmental studies is well documented (5, 6).

Several indices have been developed to measure the calculus formation rate (1, 7, 8, 9). Each index has its usefulness to the Navy depending upon the type and duration of study undertaken. Short term submarine environmental effects have been evaluated by the standardized foil technique (10) and by the marginal line calculus index (11). A six-month study was conducted in the Antarctic (12) using both the standardized foil technique and the index described by Volpe, Manhold and Hazen (8). It was found that both indices were reproducible in an individual in a longitudinal study, however, the Volpe-Manhold index was by far the simpler to use. One problem remained with the use of this index; the question of simultaneous calculus sampling for component analyses. A study was, therefore, designed to explore the relationships between the formation rate index and the chemical nature of the calculus formed. In addition to this basic question, some refinements and simplifications of the Volpe-Manhold test were to be attempted.

MATERIALS AND METHODS

This study was conducted at McMurdo Sound, the Navy's main operation Deep Freeze base during the austral winter 1968.

Twenty volunteers from the personnel of this base were accepted as subjects for the study. Initially, the lingual surfaces of the six lower anterior teeth were freed of all calculus and were polished. After one and two months the subjects were recalled and the calculus was scored by the refined method of Volpe and Manhold. At the end of the third month, the calculus was scraped off the test

teeth and was stored for analysis. The teeth were then polished and the entire procedure was repeated for another three-month period.

At the end of the study the calculus samples were shipped to the Submarine Medical Research Laboratory for chemical analysis. The sample from each tooth surface was dissolved in 50 microliters of 3N hydrochloric acid. A twenty microliter sample was then diluted to 120 microliters with distilled water. Calcium was determined by the micro method of Diehl and Ellingboe (13) and phosphorus by a micro adaptation of the method of Fiske and Subbarow (14). All values were reduced to micrograms of calcium or phosphorus in the calculus sample and calcium-phosphorus ratios were computed from these data on a weight/weight basis.

RESULTS

The calculus scores at the end of one, two and three months are given in Table I. The "partial score" notation refers to the method of deriving the index as originally described by Volpe, Manhold and Hazen. In that method only the area of greatest build-up of calculus is scored on each tooth. The total score is based on the amount of calculus in millimeters scored on three definite areas of each tooth. This total score is described as a later refinement of the index. It is to be noted that the greatest increase in calculus formation occurs between the first and second month and that an extremely strong correlation exists between the two methods of scoring.

Tables II, III, and IV depict comparisons between the first and second series of calculus formation measurements as computed at the ends of one, two and three months. The two series of collection periods are labelled early and late winter as a matter of convenience. It is noted in Table I that a rather large but not statistically significant difference was present between the early and late winter scores when the one month formation periods were compared. The correlation coefficients

TABLE I
Calculus scores at different time periods.

Time	N	Partial Score	Total Score	Correlation	Linear Regression
One month	30	1.89*±0.358**	3.21±0.018	+.97	1.76
Two months	39	3.16 ±0.318	6.00±0.802	+.94	2.09
Three months	41	3.71 ±0.365	7.45±0.997	+.96	2.17

*Mean

**Standard error of the mean.

between measurements of early and late winter were only of borderline significance for this set of data. It may be conjectured that the examiner was still relatively inexperienced with the measurement method when the first series of measurements was made. This could explain the low and rather variable values obtained in the early winter.

TABLE II
Comparison of One-Month Calculus Formation Rate in Early and Late Antarctic Winter.

	N	Partial Score	Total Score
Early winter	11	1.73±0.401	2.86±0.795
Late winter	11	3.32±0.54	5.36±0.956
Correlation		r=+ .64	r=+ .65
Linear regression		b=+ .86	b=+ .78

TABLE III
Comparison of two month calculus formation rates in early and late Antarctic winter

	N	Partial Score	Total Score
Early winter	18	3.22±0.329	6.14±0.835
Late winter	18	3.56±0.450	6.72±0.886
Correlation		r=+ .70	r=+ .78
Linear regression		b=+ .95	b=+ .83

The values obtained at the two- and three-month collection periods (Tables II and III) show close agreement between the early and late winter formation rates. The correlation coefficients in these cases are highly significant ($P<.001$) indicating a high degree of individual reproducibility when using this measurement method.

The calcium phosphorus ratios of the calculus samples are given on a weight/weight basis in Table V. There is seen to be a high degree of individual reproducibility of these calculus components. The correlation coefficient between the two test periods is highly significant ($P<.01$). It is interesting to note

the negative, albeit not statistically significant, correlation between the calcium-phosphorus ratios and the total calculus scores.

TABLE IV
Comparison of three month calculus formation rates in early and late Antarctic Winter

	N	Partial Score	Total Score
Early winter	20	3.75±0.349	7.40±0.907
Late winter	20	3.80±0.512	7.38±1.066
Correlation		r=+ .78	r=+ .81
Linear regression		b=+ 1.15	b=+ .96

TABLE V
Calcium: Phosphorus ratios of calculus samples

	N	Ca/P	Total V-M score	Correlation
Early winter	15	1.91±.043	5.97±.764	r=−.44
Late winter	15	1.94±.063	6.87±1.038	r=−.27
Correlation		r=+.69		

DISCUSSION

The reproducibility of the Volpe-Manhold calculus index was again demonstrated in this study. The mean values in the present study agree very closely with those reported previously for Antarctic personnel by Gould and Shiller (12). It should be noted that only the single greatest score for each tooth was used by Gould and Shiller. Their data, then, would correspond to the partial scores reported in this paper.

The manner in which the data were collected enabled a determination of the effect of partial scoring versus the refined total scoring method and the effect of reducing the collection time. The data indicate that the two methods of scoring correlate well with each other (Table I) and in individuals at different times (Table II, III and IV). One

possible advantage to the refined total scoring method is the fact that a greater spread of values are possible in a longitudinal study. The progression of partial scores was only .48 units from the first to the third month in the late winter period while the total score method yielded a spread of 2.02 units. This added range of values might be of benefit in some types of studies.

The optimum time for calculus collection for this index determination was an important aspect of this study. Volpe, Manhold and Hazen used a three-month collection period; this time was also used by Gould and Shiller. If one looks at the overall data in Table I, it would appear that a steady progression is present in calculus accumulation. It was mentioned earlier, however, that the first month scores of the first test period seemed inordinately low and variable, possibly due to an initial impression of the examiner. If we continue our examination to the late winter series of measurements (Tables II, III and IV), it appears that the greatest score increment by far occurs in the first month and certainly not much is gained by going past the second month.

The calcium phosphorus ratio is generally regarded as an indication of the maturity of calculus deposits; the higher Ca:P ratios being indicative of the more hard, mature calculus. It was most interesting to note the high degree of correlation between individuals Ca:P values at the two evaluation periods. The fact that a negative relationship was present between total scores and Ca:P ratios (Table V) should lead one to consider that the deposits measured in cases of rapid "calculus formers" would include much poorly calcified material.

CONCLUSIONS

The Volpe-Manhold method of calculus assessment is a relatively precise and reproducible method for calculus formation rate assessments. Its ease of use recommends it for population studies.

Depending upon the study being conducted the use of only one maximum score for each tooth (partial score) and a collection time

period of no more than two months would appear to be warranted.

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13. ABSTRACT

The high prevalence of gum disease in the Navy requires that attention be given to any factor associated with these diseases. Dental calculus (tartar) has long been implicated as having a role in gum diseases. Accurate measurement methods are required for studies in formation rates. One measurement index, the Volpe-Manhold Index, was evaluated using as subjects naval personnel wintering-over in the Antarctic. Results indicate this to be a precise, reproducible index which should be useful in any calculus study.

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